THE LAMP RFQTS: STATUS, CAPABILITIES AND PLANS

A. Alexander*, W. Choi, J. Duran, T. Grumstrup, M.A. Holloway, M.R. Howard, J.T.M. Lyles,
K. Shipman, Y. Shimabukuro, B. Sims, A. Smith, S.I. Sosa-Guitron, C. Taylor, R.T. Thornton,
Los Alamos National Laboratory, Los Alamos, United States

Abstract

The LANSCE Accelerator Modernization Project (LAMP) will replace the front-end of the existing LANSCE accelerator, from ion sources through the end of the 100-MeV drift-tube linac. The RFQ test stand (RFQTS) currently consists of an H^+ ion source, LEBT, and RFQ, but will be expanded to add an H^- ion source and LEBT. It is intended as a flexible testing platform for technology maturation and workforce development. This paper will describe the status of the RFQTS, its current and future capabilities and planned experiments for technology maturation and other applications.

INTRODUCTION

The LANSCE accelerator produces 100 MeV and 800 MeV H- ion beams, which are delivered to 5 user end stations and used for a variety of nuclear, materials, medical and other applications. LAMP will modernize and replace the first 100 MeV of LANSCE, from the ion sources to the drift tube linac [1]. The LAMP project is currently in the preliminary design phase. As part of this process, a variety of technologies must be experimentally demonstrated before the final design can be approved [2]. The RFQ Test Stand is a flexible test stand that repurposes an existing RFQ for technology demonstration and maturation for the LAMP project. A schematic and image of the RFQTS is shown in Figure 1.

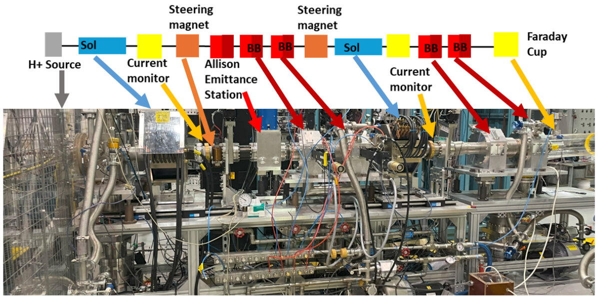

Figure 1: Schematic and photo of the RFQTS H+ beamline.

Comparison to LAMP

The RFQTS beamlines will share the same key components needed for technology maturation. However, because it uses a pre-existing RFQ, both the input and output energy of the RFQ are different from the LAMP design. The input energy of the RFQ (and thus the ion source injector and LEBT energy) is 35 keV, while the RFQ output energy is 750 keV. This is in contrast to the 65 keV LEBT/ RFQ input energy and 2.1 MeV RFQ output energy planned for LAMP [3].

H+ BEAMLINE

The H+ beamline is shown in Fig. 1. The beamline consists of a (LANSCE style) duoplasmatron H+ ion source (shown in Fig. 2), a 35 keV DC injector, and a variety of beamline diagnostics.

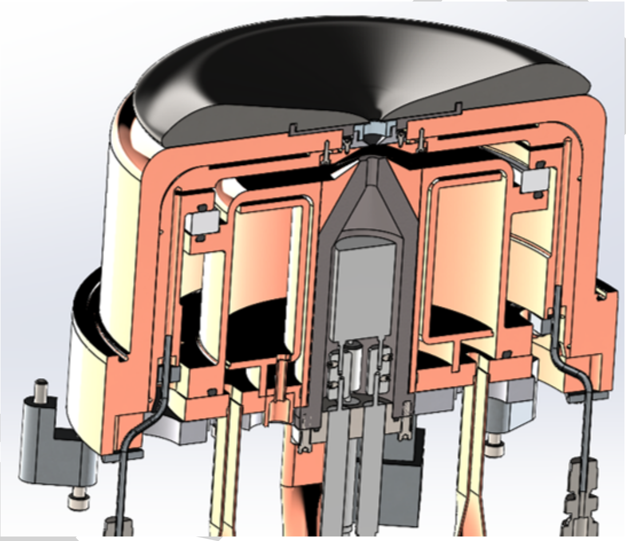

Figure 2: Schematic of the H+ duoplasmatron ion source used at the RFQTS.

The goal of the beamline in this configuration is to experimentally demonstrate a beam that will have a high acceptance into the RFQ. This is done through the slit and collector emittance stations in the second beam box. This is where the front of the RFQ will be placed when it is installed. Another key goal of the RFQTS is to demonstrate diagnostics that will be used for LAMP. LANSCE uses a slit and collector configuration to measure transverse emittance for the ion source transport lines an LEBT (i.e. energies less than or equal to 750 keV), shown in Figure 3.

This style of measurement typically has better resolution than Allison emittance scanners. However, this difference is reduced at lower beam energies. Further, Allison emittance scanners can typically measure higher peak and average power beams. This is important, as the LANSCE style slit and collector emittance scanners are permanently damaged when exposed to the beam unless the duty factor is drastically reduced. As a result, several emittance scanners are typically damaged each year due to user error. Further, there are underlying questions about measurement accuracy if the emittance scanner is needed very close to the ion source, before any choppers. In this case, the plasma pulsing must

---

* aalexander@lanl.gov

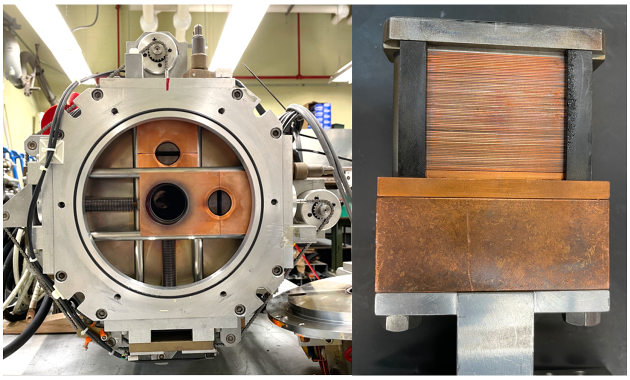

Figure 3: Image of the LANSCE slit and collector style of emittance measurement system.

be changed instead of chopping excess beam. Changes to the plasma parameters are known to change the beam properties, but this cannot be effectively measured or accounted for if the emittance scanner cannot withstand the full beam power. The RFQTS will test the use of the Allison emittance scanner for potential use in the LAMP LEBT and MEBT.

A key consideration for the H+ beamline is space charge neutralization. This is due to the long beamline and low LEBT energy. Both the LAMP and RFQTS have long LEBTs due to the need to merge the H+ and H- beams before accelerating them in the RFQ. The RFQ design also constrains the LEBT energy. Fig. 4 shows the effect of beam energy and space charge neutralization on the beam size. Space charge neutralization can be modeled to first order as an effective reduction of the beam current while modeling space charge effects. The 35 keV example is representative of the RFQTS, while the 750 keV example is relevant both for the RFQTS MEBT beamline after the RFQ, and is the same energy as the LANSCE LEBT. The 100 keV energy is an intermediate case, relevant to both the LAMP LEBT (currently planned at 65 keV) and the LANSCE H- ion source transport, which operates at 80 keV. Fig. 4 demonstrates that space charge effects are much more relevant for beam transport at the lower energies planned for the RFQTS and LAMP LEBT beamlines than they have historically been for LANSCE.

The RFQTS H+ beamline was designed assuming 90% space charge neutralization [4]. Given that the strong dependence of beam size on effective current shown in Fig. 4, a reduction in space charge neutralization can result in a significant beam losses due to beam scraping, and may also make it challenging to successfully match into the RFQ. To address this, we have begun initial beam neutralization studies [5].

Figure 5 shows how the beam neutralization fraction depends on the gas species, time, and pressure. Under typical operating conditions the RFQTS beamline pressure is ~1×10^{-6} Torr,with hydrogen the dominant constituent. A high degree of space charge neutralization is possible for any pressure of any gas given sufficient time. However, the RFQTS and LAMP beam pulse length is anticipated to be 500 μs to 1 ms. The preliminary simulations suggest that a neutralization of 90% would require milliseconds to produce given the beamline gas species and pressure. This is longer than the beam pulse and thus is problematic. However, adding argon to reach a partial pressure of 1×10^{-5} torr would result in 90% neutralization in ~ 10 μs, which is reasonable given the beam pulse length. Experiments to validate these simulations are in progress.

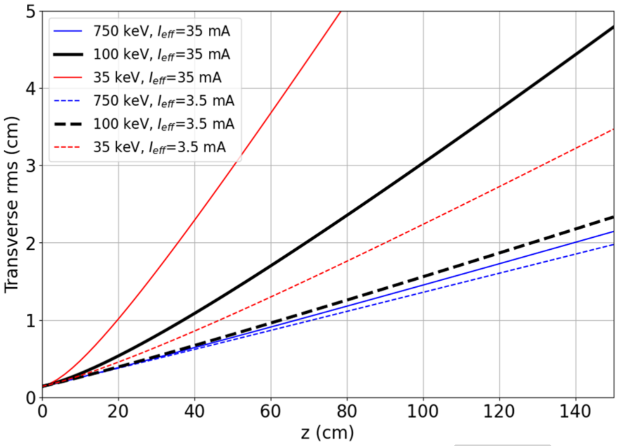

Figure 4: Simulation of beam diameter growth as a function of space charge neutralization and beam energy.

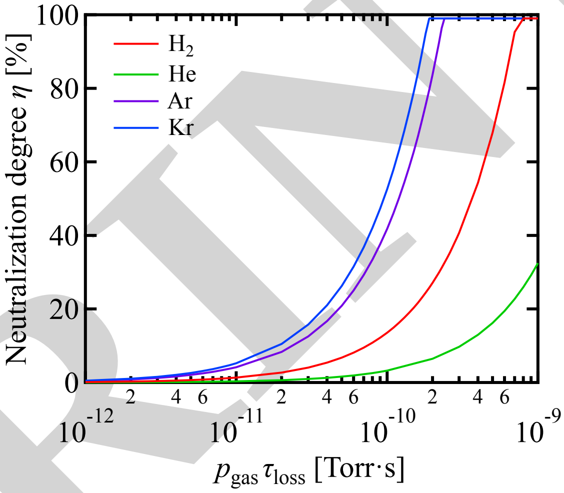

Figure 5: Dependence of beam neutralization fraction on time, pressure, and gas species.

Once the beam neutralization studies are complete, the next step will be to place the RFQ at the position of the second slit and collector emittance station. The emittance station will then be moved to the exit of the RFQ with additional diagnostics. The schematic and CAD depiction of the planned beamline are in shown in Figure 6 and Figure 7.

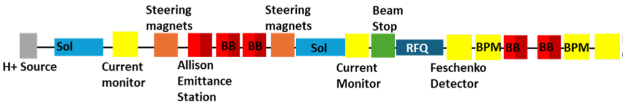

Figure 6: Schematic of the RFQTS with H+ beam being delivered through the RFQ.

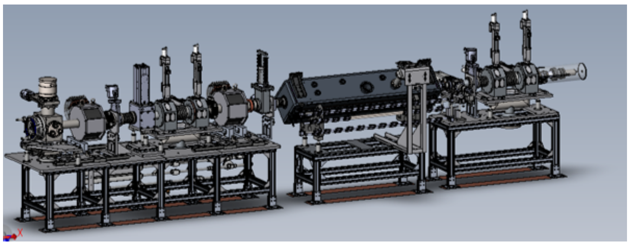

Figure 7: CAD model of the RFQTS beamline with H+ beam being delivered through the RFQ.

H- BEAMLINE

The RFQTS is also commissioning a new H- ion source, as the existing LANSCE ion source cannot meet the peak current, ion source lifetime, and ion source replacement time requirements for LAMP [6, 7]. The parameters for the LAMP H- ion source are shown in Table 1. The RFQTS and LAMP H- ion source design is based on the existing H- ion source at SNS. Initial assembly and vacuum testing of the RFQTS source is complete.

Table 1: RFQTS and LAMP H- Ion Source Parameters

Parameter	**Value**
Peak Current (Lujan)	16 mA
Peak Current (WNR)	55 mA
$^{N}_{RMS}$ Lujan (m)	.14
$^{N}_{RMS}$ WNR (m)	.19
Duty Factor	12 %
Lifetime	12 weeks
Replacement Time	12 hours

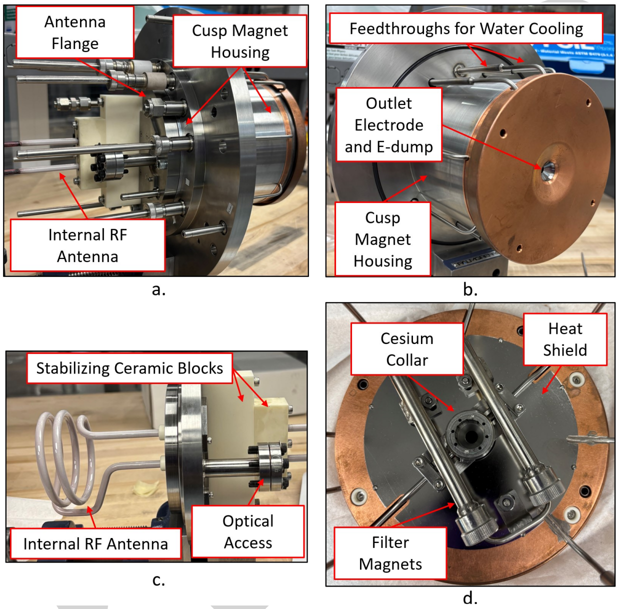

Figure 8: a.) Image of the RFQTS H- ion source. b.) Downstream view of the H- source showing the outlet electrode and e-dump. c.) The H- ion source antenna flange. d.) Image of the components in the outlet electrode assembly. For more detail see Ref. [6].

A continuous 13 MHz RF source produces a low density ”starter” plasma. A pulsed 2 MHz RF source then produces the plasma that is used to generate beam after interaction with the cesiated converter. Figure 8 shows a photo of the RFQTS H- ion source, with key components labeled.

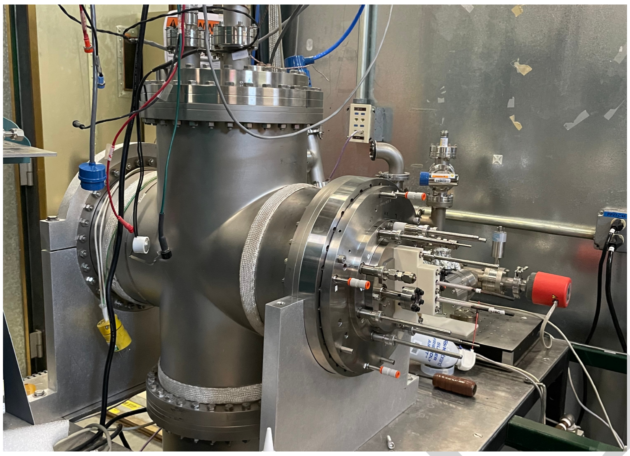

Figure 9: Photograph of the RFQTS plasma test stand.

The 13 MHz and 2 MHz RF sources are undergoing testing and the matching networks are under construction, with plasma tests anticipated later this year. The plasma testing will be done on the RFQTS plasma test stand, show in Figure 9. This was originally designed for plasma testing of the H+ duoplasmatron ion source, but is now is also capable of plasma testing the RF H- ion source as well, though only one ion source may be tested at a time.

FUTURE PLANS

The immediate goals of the RFQTS are to complete the beam neutralization experiments and put beam through the RFQ to provide datasets for LAMP model validation. The RF H- ion source must also be commissioned. Beyond this a variety of experiments are being considered. This includes testing of the ion source and injector pulsing which is now required with the new LAMP design, preliminary chopper tests, MEBT steering, and novel diagnostics.

ACKNOWLEDGEMENTS

Work was performed under the auspices of the US Department of Energy by Triad National Security under contract 89233218CNA000001.

REFERENCES

[1] J. Lewellen *et al.*, “The LANSCE Accelerator Modernization Project (LAMP): Status and Recent Progress”, presented at IPAC’26, Deauville, France, May 2026, paper WEP4328, this conference,

[2] J. Lewellen *et al.*, “Technology Maturation for the LANSCE Accelerator Modernization Project (LAMP)”, presented at IPAC’26, Deauville, France, May 2026, paper THP4303, this conference,

[3] K. Bishofberger *et al.*, “Overview of the LAMP Conceptual Design”, presented at IPAC’26, Deauville, France, May 2026, paper WEP4317, this conference,

[4] Y. K. Batygin *et al.*, “Design of low energy beam transport for new lansce h+ injector”, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 753, pp. 1–8, 2014. doi:https://doi.org/10.1016/j.nima.2014.03.041

[5] Y. Shimabukuro, W. Choi, *et al.*, “Modelling of Space Charge Compensation in the RFQTS LEBT”, presented at IPAC’26, Deauville, France, May 2026, paper WEP4340, this conference,

[6] M. R. Howard *et al.*, “Commissioning Status of the H- Ion Source for the LANSCE Accelerator Modernization Project”, presented at IPAC’26, Deauville, France, May 2026, paper THP4307, this conference,

[7] J. Lewellen *et al.*, “Requirements Evolution for the LANSCE Accelerator Modernization Project (LAMP)”, presented at IPAC’26, Deauville, France, May 2026, paper WEP4329, this conference,